Research Digest

August 1991 Number IV

New Jersey updates truck noise research

The public health and welfare was at the heart of the Noise Control Act of 1972. The Act compelled the Federal Highway Administration (FHWA) to establish noise standards for highway projects. These standards require highway agencies to adhere to maximum noise levels for proposed projects using federal-aid highway funds. If the expected traffic noise levels approach or exceed the maximum levels set by FHWA, then the highway agency is required to implement reasonable and feasible noise abatement measures.

In the early 1970s, the New Jersey Department of Transportation (NJDOT) determined that the FHWA approved computer program, which predicted traffic noise levels, was not accurate.

A statistical analysis of measured vs. predicted noise levels, which considered many factors including car and truck noise levels, indicated that the program's truck noise levels were the most likely cause of the inaccuracy. Accordingly, in the mid 1970s, NJDOT began a study to accurately determine the noise levels of trucks. The FHWA program utilized one truck class with noise levels for level roadways only; the Department study was designed to find if trucks should be grouped into different classes, and to determine truck noise levels, not only on level roadways, but also on upgrades, downgrades, and ramps.

Truck Noise Levels (dBA)*

Truck Size	Level	Upgrade	Downgrade	Ramps
Heavy	86.8	86.4	86.0	81.0
Medium	82.3	81.6	81.2	75.2

*Average speeds are 49-57 mph for road sections, 26-30 mph for acceleration on ramps.

All trucks are adequately represented by the two size classes listed on this chart. The data was obtained from pass-by measurements at 37 sites on controlled and non-controlled access highways.

Data for more than 4500 trucks was obtained from pass-by measurements at 37 sites on both controlled and non-controlled access highways. It was found that all sizes of trucks were adequately represented by two classes — medium trucks (2 axles, 6 tires) and heavy trucks (three or more axles). The results of these measurements for controlled access highways are shown in the table above.

Note that truck noise levels were approximately the same on both level, upgrade, and downgrade sections. For non-controlled access highways at speeds of 45-50 mph, truck noise levels were about 2 dBA higher on upgrade sections than on either level or downgrade sections. Truck noise levels in New Jersey were either higher or lower than the national truck noise levels used in the FHWA prediction program, depending on the type of roadway under consideration. In general, however, they tended to be slightly higher, and, for trucks accelerating on ramps, were about 4 dBA higher at speeds of 25-30 mph. Accordingly, NJDOT replaced the national truck levels in the noise prediction programs with the truck noise levels for New Jersey. These levels were used for noise prediction until the arrival of STAMINA 2.0, an upgraded FHWA noise prediction program.

A supplemental study was undertaken in the early 1980s to more accurately predict noise levels near upgrades and ramps by examining more closely how a truck's noise level and speed change throughout the length of an upgrade and on ramps. Continuous recordings of truck noise on grades and ramps were taken on board a test vehicle. Pass-by truck noise measurements were also made along a 2-mile, 4% upgrade.

The pass-by microphones were placed 2000 feet before the start of the upgrade, and 3000, 7000, and 10,000 feet into the upgrade. Heavy truck noise levels on the upgrade were not found to be appreciably higher than before the upgrade; in fact, at the 10,000 foot location, noise levels were over 1 dBA lower. In addition, heavy truck speeds measured at 10,000 feet into the 4%

(Continued on back page)

The New Jersey Department of Transportation

or Jim Florio **Commissioner Tom Downs**

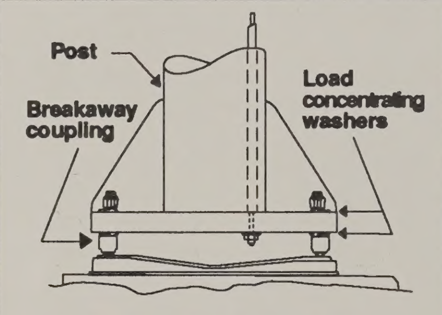
Breakaway signs help reduce the impact on motorists

As highway mileage and vehicle travel increased, so did collisions with roadside appurtenances. By the mid-1960s, with the enactment of the Highway Safety Act, the goal of saving lives on our nation's highways was emphasized through research. In the early 1970s one of New Jersey's contributions toward this goal was the development of a breakaway sign support system for large ground-mounted roadside signs (shown in accompanying photo and sketch). This sign support system was designed to break away upon impact thus reducing damage to vehicle and sign structure as well as preventing injury to the occupants of the vehicle. From a safety point of view the system has been accomplishing its main objective: that of reducing injuries and saving lives. However, components in the system were modified over the years to reduce the hardware damage sustained during an impact, therefore expediting re-erection of the sign structure. The increase of lighter vehicles on the road, with much lower impact energy, also necessitated a redesign of the breakaway couplings.

The ability of the sign support post to break away is based on two components mounted at the base of the support post: the breakaway coupling and the load concentrating washer. The load concentrating washers are designed to prevent bending of the coupling's necked-down mid-section when normal wind loads are applied to the sign panel.

The concept is based on the fact that wind load, applied to the sign in a horizontal direction, results in a bending moment at the base of the support. A counteracting movement, which substantially minimizes the wind induced bending moment, is developed by the built-in eccentricity of the load concentrating washers. The couplings act as the sacrificial breakaway device when the post is impacted by an errant vehicle. When a vehicle impacts one of the sign's support posts, about 18 inches above the ground, the load concentrating washers are not effective in cancelling the vehicle induced bending. As a result the post and its base are moved in the direction of the impact, causing the couplings to bend and break at the necked-down section. When the couplings break due to an impact, the post base rotates up and out of the way of the errant vehicle. The post is prevented from flying completely free of the sign structure by a wire rope cable attached to the back of the sign panel. This cable is part of a shock absorbing system installed within each support post.

To ensure that the couplings will break properly with the reduced impact energy of today's lighter cars, a special high tensile/low toughness alloy steel was required. The high tensile strength of this steel ensures that even the largest signs can withstand design wind loads while its low toughness property permits the couplings to break rapidly, resulting in minimal change in the momentum of the impacting vehicle. A sign structure incorporating the new breakaway coupling design was crash tested using 1,800 lb. vehicles in accordance with National Cooperative Highway Research Program (NCHRP) Report No. 230 procedures. The test results showed that the modified coupling design complied with the safety requirements for high (60 mph) and low (20 mph) speed impacts. Minimal damage was incurred by the test vehicles and sign structure components. The New Jersey Department of Transportation plans and specifications for the sign support system have sincebeen revised.

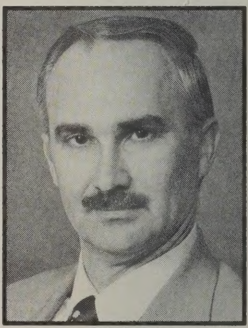


Breakaway Sign Suport Base

After almost two decades of use, at least 68 of the 500 to 600 pre-modified breakaway signs have been impacted by errant vehicles. About half of these incidents have been documented by police reports while the remaining are suspected of being hit-and-runs with little information available on the circumstances. The incidents documented by the police indicate only eight injuries, consisting mainly of scratches and complaints of pain. Considering the past experience with the New Jersey breakaway sign system and the results of the full scale crash tests, it is anticipated that the modified design will result in an even greater level of safety for the motoring public. Functioning of the system is also expected to result in less hardware damage on impact and, consequently, expedited re-erection of the signs.

A technology transfer manual and video tape were prepared to provide Construction and Maintenance personnel with the latest information regarding the operation, construction and maintenance of the sign support system. The videotape and the manual detail each step required for assembling the system. The manual also includes information concerning the system's theory of operations, coupling fabrication, and details for the systems's design and construction. The videotape and manual will be distributed by the FHWA as a technology transfer package in the near future. For further information concerning the New Jersey breakaway sign support system and availability of the manual and videotape, contact Wladislau M. Szalaj at (609) 292-4718.

This photo shows how the breakaway sign allows a vehicle to pass through the sign post without causing the car to stop on impact.



Szalaj

Wladislau M. Szalaj, the project manager, has been employed with NJDOT for 16 years. He earned a B.S. in Civil Engineering from the New York Polytechnic Institute in 1974 and received New Jersey Public Manager Certification in 1988. Szalaj has developed expertise in the field of highway safety features. His many accomplishments include evaluation of wide edgeline marking, highway shoulder use, improved maintenance methods for crash cushions, and evaluation of small sign supports. He currently coordinates the Rural Technical Assistance Program (RTAP) in New Jersey.

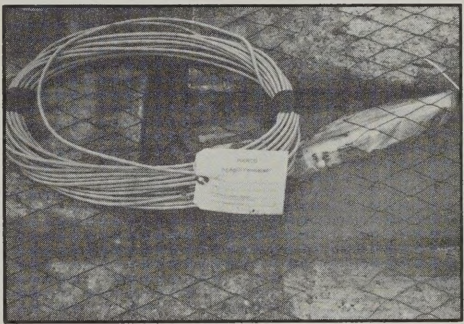
Cathodic protection could save time and mo

For many years, the oil and gas industry has used a corrosion prevention technique known as cathodic protection (CP) to safeguard buried pipes and tanks. This technique applies an electrical charge to neutralize the currents generated during the electro-chemical process of oxidation. In the mid-1970s, highway engineers across the country began to use CP in a new application — to combat corrosion of the reinforcing steel in concrete bridge decks. By arresting the corrosion of the reinforcing steel, CP is expected to extend the life of a moderately deteriorated deck by some 20 to 30 years. Additionally, significant savings in reconstruction costs can be realized, since the use of CP eliminates the need to remove salt-laden concrete.

Chloride-induced corrosion of reinforcement steel is the primary cause of premature bridge deck deterioration. The need for a more cost-effective means of combatting this problem is well known. The U.S. General Accounting Office estimates the cost to rehabilitate about 160,000 deteriorated decks nationally, using conventional repair strategies, would be more than $85 billion. Those conventional strategies — which include various types of special concrete overlays, membranes and sealants — are really stop-gap measures since they typically extend deck life only 10 to 15 years. In contrast, CP abates the corrosion mechanism and offers a solution that is potentially twice as effective.

Using CP on a bridge deck is a much more complicated procedure than protecting a buried tank, requiring many interconnected wires and sacrificial metal elements (anodes). Fortunately, industry has responded to this problem by developing a number of innovative designs including a prefabricated mesh (see figure). The CP mesh is unrolled, fastened in place on the deck, and covered with an inch-and-a-half thick concrete wearing course. Once in place, the typical CP system requires only the current needed to operate a 100 watt light bulb.

The NJDOT's first CP installations were made in late 1988 on 18 rehabilitated bridge decks on I-80 in the northern section of the state. I-80 is New Jersey's primary east-west highway and carries an AADT of about 83,000. The structures on this experimental project are 16- to 20- year-old conventional slab/girder bridges. Condition surveys of the decks prior to CP installation revealed that, although they contained high levels of chlorides and were actively corroding, the decks were structurally sound and only moderately deteriorated. Because the decks did not require complete deck replacement, these bridges were excellent candidates for an experimental CP installation.



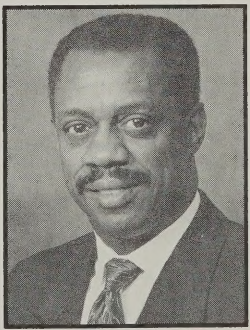
Pictured above is some of the typical wiring used for cathodic protection against corrosion of the reinforcing steel in concrete bridge decks.

Three different types of anode systems were installed on the I-80 bridges: a rigid conductive polymer concrete, a flexible conductive polymer and a metallic mesh. The installation of the conductive polymer concrete system was labor intensive and required mixing and handling of hazardous components. The prefabricated flexible polymer and metallic mesh represent the state-of-the-art in anode materials. The metallic mesh has become the industry's system of choice due to its ease of installation and purported superior durability.

The test installations are inspected and monitored bi-monthly by collecting and analyzing readings for current flow, voltage and corrosion activity. Much of this research data is provided by state-of-the-art remote monitoring equipment installed during the construction. The ongoing analysis of this data is designed to provide greater insights regarding the relationships between such factors as current density, corrosion activity and weather conditions. To date, data from embedded monitor probes — used to measure corrosion activity and determine current requirements for adequate corrosion control — indicate the CP systems are performing satisfactorily. Additionally, data from semi-annual testing (depolarization) to ensure deck steel is being properly protected also indicate the systems are performing as designed.

The chief benefit of CP is long-term protection against the corrosion of steel in salt-laden concrete. Another benefit is the savings in construction costs realized by eliminating the need to remove sound, but salt-laden, concrete. (Conventional rehabilitation methods normally require all salt-laden concrete to be removed. The presence of salt is beneficial to CP installations, since salt promotes the flow of the electrical protection current.) The savings in concrete removal is directly proportional to the quantity of concrete left in place. An estimated net savings of $570,000 in construction costs was realized on the I-80 project. In view of the recent decline in the cost of CP systems and the hands-on experience gained by the Department and contractors, even greater savings are expected in the future.

An additional CP installation is scheduled to be undertaken in 1990. The evaluation of the installed systems — a joint effort between the Divisions of Research and Design — is expected to provide a better undertsanding of the performance characteristics and specification requirements of CP systems. A report summarizing the construction and initial performance of New Jersey's CP systems will soon be available from the Project Engineer, Carey L. Younger.



Younger

Carey L. Younger, the project manager, has worked for the Bureau of Transportation Structures Research for the past 23 years. He has an A.A.S. Degree in Civil Engineering Technology and is a student at Thomas A. Edison State College. He is a member of the National Association of Corrosion Engineers and the New Jersey Committee on Corrosion. In addition to his work in bridge deck rehabilitation, Younger is currently involved in pavement marking, pavement riding quality and superplastized concrete evaluations.

Published by the New Jersey Department of Transportation, Division of Research and Demonstration.

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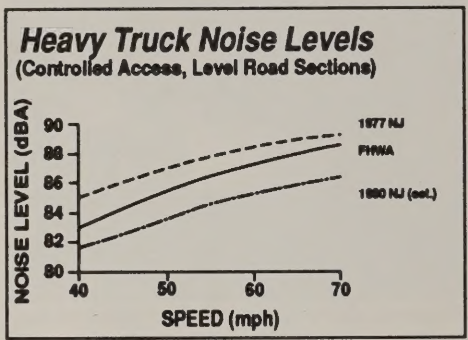
Truck noise *From page 1*

upgrade were about 6-13 mph higher than the truck speeds given in the performance curves in the 1985 Highway Capacity Manual.

In 1987, using noise and speed data from the on board and pass-by measurements and other available information, NJDOT developed a simple method for more accurately predicting roadside noise due to heavy trucks on interstate highway upgrades. This replaced a mathematical model which considered non-constant speed and varying truck noise level, but was too complex for practical application. The simple method is based on the assumption that a truck's average speed on an upgrade and the associated noise emission level can be used to predict noise levels beside the highway. The method consists of (1) a computer program to calculate average speed, which is based on the University of Michigan Transportation Research Institute's speed loss on upgrade equation and (2) the noise level vs. speed equation for heavy trucks on upgrades determined for NJDOT's initial truck noise study, revised downward by 3 dBA to reflect the lower levels measured in the mid 1980s. This method provides average speed and truck noise level inputs to STAMINA 2.0.

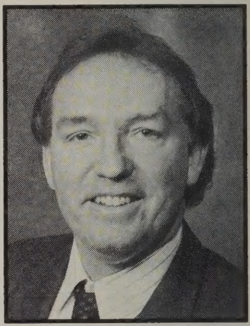
A comparison of measured and predicted noise levels indicated that the simple method used with STAMINA 2.0 predicted noise levels more accurately (about 1.75 dBA lower) than STAMINA 2.0 alone. Thus the supplemental study recommends for interstate highways, that the 2-5 dBA upward adjustment of heavy truck levels for upgrades contained in STAMINA 2.0 should not be applied, and that the simple method should be implemented by incorporating it into STAMINA 2.0.

The lower heavy truck noise levels found in the mid 1980s by NJDOT and other New Jersey highway agencies, coupled with stiffer noise regulations in 1986 for in-use trucks and 1988 for newly manufactured trucks, recently led NJDOT to undertake a large scale study to update the truck noise levels measured more than 10 years ago for the initial study. As shown in the figure, we expect to find that New Jersey's truck noise levels are significantly lower than the FHWA national levels now used.



When the simple prediction method for upgrades is put into use, and present day NJ truck levels are determined, more accurate predictions of noise levels near highways will result. Consequently, there should be fewer and less severe projected noise impacts for new highway projects. Thus, more accurately predicting community noise levels will reduce the cost for expensive noise mitigation measures, such as highway noise barriers, yet continue to protect the public from high traffic noise levels.

For further information, contact Robert Sasor, (609)-292-4579. An interim and final report for the initial truck noise study and a final report for the supplemental study are available upon request.


Sasor

Robert Sasor holds a B.S. degree in Mechanical and Aerospace Engineering from Rutgers University. In addition to truck noise, he has worked on various research studies which include highway noise complaints, tire noise, solar energy, electric vehicles, and pavement heating for snow removal.

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